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The Study of Insects in the Public Schools

BY

THOMAS B. SYMONS.

INTRODUCTION.

The progress of modern education has demonstrated the fact that new subjects have proved themselves to have as great utility as many of those contained in the older curricula in accomplishing the purposes of education. It has not been many years since the introduction of manual training to the crowded curricula of our public schools excited the apprehensions of many of our worthy pedagogists, but who will now attempt to minimize the benefit of such industrial training in our public schools?

The different phases of agricultural education are meeting the same objections in their introduction to rural and high school curricula. The extension of Nature study comprises no doubt the most reasonable method of promoting agricultural education. Particularly should this study be emphasized in our rural schools, for it aims to bring the student into intelligent and sympathetic co-operation with the world in which he must live and labor.

To the end of offering further suggestions regarding the economic as well as pedagogical importance of Entmology to the teachers of the public schools of Maryland this brief bulletin is written repeating information as regards the collecting and preservation of insects. Later we hope to issue a bulletin giving simple tables of classification of our more common insects.

PEDAGOGIC IMPORTANCE.

How many of us realize the value of the verdant field for observation, the practically unlimited and convenient opportunity for acquisition of specimens for demonstration of the laws of Nature applied to the Animal Kingdom and of the practical economic problems that may be presented in the study of our insect life? There is no branch of science that

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offers a broader or more constantly increasing interest to the student, be he young or old, than Entomology. It is said that we seldom appreciate that which is given us; and this statement is indeed applicable to those worthy pedagogists who have outlined the curricula of our public schools in which this science is not now taught, even to a limited extent, by nature study. Truly, they have appreciated neither the ease and inexpensiveness of taking up the study nor the knowledge of fundamental principles that will especially result from such observation and practice. Dr. L. H. Bailey has well said that "The child of today is living in one world and going to school in another." This is particularly true of the pupils of the majority of our country schools with regard to their knowledge of the more common insects which the children constantly observe from day to day doing serious injury to the crops upon which the pupils may be dependent for subsistence.

While the science is correctly called Entomology, the word Entomology applies to a subject, and conveys to most minds the thought of its technical side, while the word "insects" applies to things, and is much simpler for the child to comprehend. There is no doubt that we are constantly disregarding the well-known laws for the development of the child's mind, and the fact that in the growth of the intellectual faculties, the sense of perception must precede the formation of concepts, reasoning and judgment.

In selecting representatives of these forms of animal life, the ease of obtaining and handling specimens, of keeping them alive; and watching their habits, are among the first important considerations. The abundance and convenient size of insects make it easy to study them. They can be found wherever man can live, and at all seasons. They live in the air, in the soil, on the water or beneath its surface. They feed upon plants or animals, as parasites either outside, or within the bodies, of the latter. Often they devour their own kind and themselves serve as an important element in the food of many animals. They exhibit the highest stage of perfection yet obtained by animals in the transformation of chemical energy and can do more work in proportion to their size than any other animal.

Success in the study of insects will depend largely upon the skill displayed by the teacher or student in adapting the work to local conditions. Visit the forest, the orchard, the

roadside and the pond, and the observant student will find much to attract his attention, especially the different forms of insect life inhabiting each. Everything possible should be done to make this study a recreation which the pupils will enjoy outside of school hours. Let each have his own collection. Do not discourage the pupils by requiring them to memorize abstract statements concerning insects, but cause them to develop the power of accurate observation and of careful comparison. This should be the real source of their information. The development of the habit of ascertaining facts for themselves is one of the greatest benefits the pupils will derive from the study.

ECONOMIC IMPORTANCE.

The science of Entomology is everywhere coming to be recognized as of great practical importance; and this is especially true of its economic aspect. Their important relation to man as enemies of his crops and, as comparatively recent discoveries have shown, as a grim menace to his own health and life, destroying annually, according to estimates of the United States Department of Agriculture over $800,000,000 of grains, fruits and vegetables and being apparently responsible for the dissemination of some of the most serious diseases, forces our attention to these little animals. On the other hand, few of us realize the good that is done by the beneficial insects, of which there are many species. Some of our worst pests are held in check by natural insect enemies. Both the importance of this science and the appreciation of the work of Entomologists are further shown by the substantial assistance rendered them by Congress, State Legislatures and various institutions where the science is made an important feature of the work.

It is rather significant that at the annual meeting of the American Association for Advancement of Science held in Chicago, December last, the speaker in an address of welcome to the visiting scientists emphasized the triumphs of science in recent years by five illustrations, three of which were from the field of economic entomology. It is to this practical and inviting field of work that we invite students.

Many of our common foes could be discussed in the school room, and the information that the pupils would receive would often be of much profitable use practiced in and around their

homes. They would call their parents' attention, no doubt, to existing injury from pests, which would be sufficient incentive to take steps to control them. As an example, suppose our pupils in the public schools of this State were caused to study the San Jose scale in their nature study courses. There is nothing difficult to learn about the insect, nothing which the boy or girl would not comprehend if presented in a correct and simple manner. If specimens of the insect attacking one of its food plants were secured by the teacher, the students would soon learn to identify it and they would make it a point to examine the orchards on their home place or surroundings to see if the pest was attacking the trees. The life history of the pest would soon be known by the pupils as well as the means of control, and this would be transmitted to the parents, thus a whole neighborhood would have some knowledge of the insect to serve at least to arrest attention to any abnormal condition of their trees.

Again a simple study of the common housefly by our pupils would, I feel sure, bring about improvement in the sanitary condition around the home.

Facts about the housefly, such as on account of the conformity of its mouth parts it cannot bite, that the eggs are usually laid in horse manure, that the life history is usually passed in about ten days and that it is an important medium in the dissemination of intestinal diseases, especially typhoid fever, can easily be taught the pupils.

Likewise the habits and life history of that common pest the mosquito can be brought to the attention of our boys and girls. If they were taught that the common house mosquito does not fly over two hundred yards from its breeding place and that the pest breeds in stagnant water around the house either in the rain barrel, old tin cans, crocks etc., the writer feels sure that these pupils would see to it that such breeding places are not maintained around the house. By impressing the child that malaria and yellow fever are disseminated by certain species of mosquitoes the teacher would awaken the neighborhood to the importance of mosquito control.

The simple fundamental principles of insect control viz., that insects do injury principally by sucking or biting and that in controlling the former contact insecticides are usually employed and for the latter stomach poisons, also the general means of combatting those not included in the above, and

furthermore the usefulness of many beneficial insects that could be identified are all different aspects in the study of insects that could be taken up in our public schools and go to show the economic importance of the subject.

COLLECTING INSECTS.

While much can be learned by merely watching insects in the field, in order to study them thoroughly it is necessary to collect specimens. In doing this we should be as humane as possible. While there is no doubt that insects are not so sensitive to pain as are higher animals, they certainly suffer to some extent when injured. Therefore they should be handled with great care, and killed without inflicting needless pain. Here we have a lesson which the teacher can impress upon the young minds, that of not being cruel to animals. As stated elsewhere, insects can be found almost anywhere. The pupils can collect them while going to and from school or at recess, but a class should be excused for an hour or two to make longer trips and should be accompanied by the teacher. The ideal time for collecting insects is on warm days when the sun is shining.

Collecting Outfit. A collecting outfit should consist of a cyanide bottle, a net, a few small vials, some containing alcohol, and three or four pill boxes for bringing home live specimens. In collecting butterflies great care must be exercised not to rub the scales from the wings. It is a good plan to carry along folded papers or small envelopes in which you can put the insects after they have been killed and thus carry them to the laboratory without mutilation.

Killing or Cyanide Bottles. Many chemicals can be used in killing insects without causing them to suffer to any extent and without mutilating them. By saturating a piece of cotton with either chloroform or sulfuric ether, and enclosing it with the insect in a tight box or bottle the desired effect will be secured. But the most convenient and common method is by the use of a cyanide bottle. These bottles should be prepared by the teacher or a druggist. **Too much care cannot be observed in the handling of this chemical as it is one of the most deadly poisons known.** If it is used according to the following instructions, however, no fear need be entertained. There are many ways of making a cyanide bottle, but the

simplest is to take a wide-mouthed bottle holding from four to six ounces. Put in the bottle one or two pieces of cyanide of potassium about ½ inch in diameter or one piece about ¾ inch in diameter. Now fill the bottle about a third full of fine sawdust and pack down as solid as possible. Cut a piece of stiff cardboard in a circle, the diameter equal to that of the inside of the bottle, and put a little mucilage on the underside. Place this on the sawdust, pressing it down well. You now have a cyanide bottle, which if properly taken care of will retain its strength for months. Never leave the stopper out of the bottle for any length of time. After making a cyanide bottle be sure to label it **poison.** Always advise the pupils as to the deadly character of the poison, so that they will never touch the cyanide. Fig. 1 shows a four ounce bottle made with sawdust and cyanide as indicated. Another method of making a cyanide bottle is after putting into the bottle the amount of cyanide of potassium as stated above, to add water enough to cover the chemical and immediately put in enough plaster of Paris to soak up the water. In this way the cyanide will be more firmly cemented in the bottom of the bottle than in the first method mentioned. A cyanide bottle about one fourth of the size of the one described above is useful to carry around in one's pocket during the collecting season, see Fig. 2. Insects to be killed should be left in the bottle at least a half hour, but allowing them to remain longer, or even over night, will not injure them.

FIG. 1.

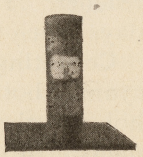

FIG. 2.

Insect Nets. While a net is not necessary to catch insects, it is advisable in order to catch a number of the members of the class which are strong jumpers or flyers. The form of net shown in Fig. 3 is usually employed. This can be made by taking a piece of No. 3 galvanized iron wire and bending into a ring about a foot in diameter. The ends of the wire should be twisted and tightly fastened to a light wooden handle such as is fitted to a broom. The ring should be covered with a strong piece of unbleached linen, and to this is sewed a bag made of strong cheesecloth,, about two feet long, being the diameter of the ring where it is sewed on.

and tapering slightly towards the bottom. The bottom of the net should be rounded, and without corners or points in which the insects can lodge. This net can be used in catching insects flying in the air, and also those that rest on the grass, weeds, etc.

FIG. 3.

Vials and Pill Boxes. . . It is always well to have a few vials and pill boxes along on a collecting trip in which you can place small, delicate insects alive or dead; especially are they useful in carrying home living specimens of adult, pupae or larvae. In collecting soft-bodied insects and spiders it is best to have two or more vials filled with alcohol.

Paper Envelopes. This is what is referred to elsewhere in mentioning the manner in which lepidopterous insects may be carried. After killing the specimen by pinching the thorax, it is dropped into an envelope, such as a small drug envelope or the larger pay-roll envelope which can be bought for a comparatively small sum at any stationer's. In this way the in-

sects can be carried in a small flat box without danger of breaking any of their parts. If the specimens are kept for any length of time in this manner they should be moistened by placing on damp sand before handling. It is hardly necessary to secure envelopes, however, if you can provide yourself with a very large cyanide jar prepared as the cyanide bottle, as the butterflies and moths can be put into the jar without danger of injury.

HOW TO COLLECT INSECTS.

With the above apparatus the collector can start out almost anywhere in the warm season of the year, and if on the alert he will see numbers of insects. One should go slowly, examining all herbage, foliage of shrubs and trees, and he will observe many tricks of the insects. He should use his net in catching active insects, but in collecting generallly the net is also used for what is commonly called "sweeping." This consists in passing the net to and fro about two feet in front of you over the grass and herbage. The net must be turned at the end of each stroke, and must be kept in rapid motion so that the insects cannot escape from it. When a large number of specimens have accumulated in the net they should then be transferred to the cyanide bottle.

An excellent method of taking specimens at night is to open the window close to a light. In this way it will be found that many insects can be captured which one will never see during the daytime. The method known as "sugaring" is also practiced at times. This consists of smearing, with a solution, of paint consistency, made of molasses and stale beer, the trunks of trees on the edge of the woods or in a yard surrounding a house, or it may be applied anywhere to fences, that are likely to be surrounded by insects at night. The solution should be applied about sunset, on the places designated, in strips about two inches wide and several inches long. These patches of sweet solution will attract nocturnal insects, especially moths, and the collector can visit these baits after dark and there will be found hovering about them on the trees and fences many specimens which he can easily trap.

THE BREEDING OF SPECIMENS.

The best method of obtaining perfect specimens is by breeding them. Especially is this true with moths and butterflies. They do not have a chance to mutilate themselves, and also there is no danger of the collector's injuring any of their parts. Although breeding insects involves a good deal of labor and care, it affords a most delightful field for observation in the school, and the returns are frequently of great value. A point to be emphasized is, that in collecting insects and larvae for the breeding cage one should observe the kind of food they eat when unmolested, as it is necessary to furnish them with an abundance of this food when they are confined. If they live in water, determine whether they will require running water or can be kept in an ordinary aquarium.

The boxes, suggested as a part of the collector's apparatus are used principally to carry such specimens as he wishes to keep alive in the school or laboratory.

Breeding Cages. There are a great many kinds of breeding cages, but it is only necessary to cite the simplest in this discussion. This is represented in Fig. 4. It is made by combining a flower pot and a lantern gloge. If convenient, the food plant can be planted in the pot; or, if not, a small tin or bottle filled with water may be placed in the earth and the stems or other material can be kept fresh for a time by keeping the lower ends in water. The top of the globe should be covered with a fine mosquito netting which can be held in place by either a string or a rubber band. Of course larger pots and correspondingly large glass cylinders as represented in Fig. 5 may be used. These pots are readily moved from place to place and are especially convenient for watching the insects confined.

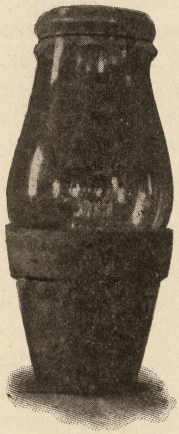

FIG. 4.

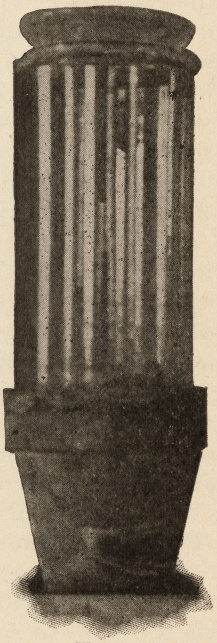

FIG. 5.

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Aquaria. For keeping and breeding aquatic insects some form of an aquarium is needed, but it need not necessarily contain running water. Of course, if such is convenient, it is very desirable. Any ordinary jar can be used. It is a good plan to keep some kind of water plants in the jar, as the water will be kept in a better condition and it will not be necessary to change it so often.

THE PRESERVATION OF SPECIMENS.

After a collecting trip, specimens collected should be mounted immediately, as they can be handled more easily then than at any other time. All insects that will preserve their forms when dry should be pinned, with specimens of their nests or work, mined or rolled leaves, or other similar objects. Immature forms of all insects, adult insects which have soft bodies, or specimens intended for anatomical study should be preserved in alcohol or some other preserving fluid. Some insects of minute size should be mounted in Canada balsam upon slides.

Insect Fins. There are many styles of insect pins employed, but those used generally by American entomoligsts are known as German pins. They are rather long and slender, and are preferred for this reason, as they keep the specimen higher from the bottom of the box than ordinary pins. It is also desirable to use these pins; for if shorter ones are used, and at any time one should wish to change specimens, some difficulty would arise on account of the difference in the size of the pins. These German pins are made in different sizes of wire and are numbered accordingly. It is left to the judgment of the collector what size to use for the different sized insects. They can be purchased from any establishment dealing in entomological supplies. If it is not possible for the teacher to secure these pins, the common brass pins which are somewhat thicker and shorter can be used. The ordinary mourning pins have better points than the common brass pins and may be preferable for this purpose, especially when cork or pith is not used in insect cases.

Pinning Specimens. In a properly arranged collection it is of prime importance in pinning specimens to have them uniform both as to the position of the insect on the pin, and also the place of inserting the pin through the insect. A good

rule to remember in pinning insects, is to project the pin through the middle of the thorax of the insect. There are exceptions to this rule, however, especially in the case of beetles, which should be pinned through the right wing cover, at about one fourth of its length from the base as shown in Fig. 6, and also in pinning what we may call bugs (order Hemiptera), which should be pinned throught the scutellum, the triangular plate on the back.

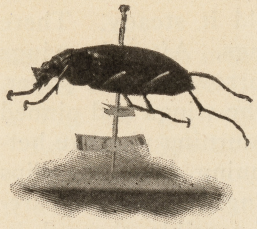

FIG. 6.

In order to secure uniformity in the position of insects on the pins, a device shown in Fig. 7 is convenient. This consists of three small strips of wood one fourth as thick as the pins are long and fastened together as shown. A hole just large enough to allow the passage of the head of the insect pin in use is bored through the center of each step of the block. In pinning an insect, the pin is pushed through the insect so that less than one-fourth of its length projects above it, and the insect is pushed back into the proper place by inserting the head of the pin in the hole in the lower step of the block. This step and the second are used in fixing the height of insects mounted on cardboard tips.

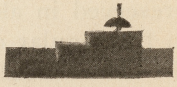

FIG. 7.

When it is wished to pin an insect which is too small to pass a pin through and which is not desired mounted on glass slides, the insect may be stuck, by means of a small amount of mucilage, to pointed pieces of cardboard as shown in Fig. 8.

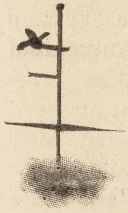

FIG. 8.

Much more attention is necessary in pinning the members of the order Lepidoptera, or moths and butterflies, than other insects. As stated elsewhere care must be exercised in handling them so as not to rub the scales off their wings.

After the pin has been thrust perpendicularly through the thorax, the insect should then be placed in a setting board. Setting boards are pieces of wood having a groove on the upper surface of sufficient depth to accomodate the body of the insect and to permit its wings to be brought on a level with the upper surface of the board. On the bottom of the groove should be tacked a piece of cork or pith into which the

pin inserted through the insect may be thrust down below its body for a considerable distance, to hold it steady. There should be uniformity in arranging the wings. After the wings are put in position and held there by narrow slips of paper, wider slips of paper or mica are laid on the wings and pinned down. For this purpose sharp pointed mourning pins are better than the ordinary brass pins. In pinning down the slips of paper or mica which are to hold the wings in place, be careful to pin around the wing,. but never, if possible, through it. The specimens should be left in this manner for from three to six days,or until the wings will hold their positions when the mica or paper is removed. The wings of other insects may be spread in the same manner.

Inflating Larvae. While the larvae of insects are usually preserved in alcohol, it is often wished to pin the specimen in the regular collection with the adult. In order to do this the larvae must be inflated so that it will not decay. In inflating the larvae the first step, after killing it in a cyanide bottle, is carefully to remove the contents of the skin. This is done by inserting a stout pin or needle into the anal extremity. Lay the specimen on a sheet of paper, and placing a pencil across it just back of its head, press out the contents of the abdominal cavity. Care must be exercised to apply only enough pressure to expel the contents of the skin without mutilating any of the tissues which lie nearest the epidermis, or the hairs which may be attached to the body. Now insert a straw, or glass tube, previously heated, in the anal opening and close the opening perfectly with glue or collodium, if necessary, and inflate,hold it while inflated in a hot place to dry.A convenient method of drying it is in an oven made by laying a large lamp chimney across a tray of sand over a lamp. (See Fig. 9.) Hold the specimen in the heat until thoroughly dry, but in drying the skin care must be exercised not to heat it so much as to destroy the colors. When the skin is dry remove it from the tube and mount it on a piece of copper wire wrapped in green silk, which has been bent around a small piece of cork, through

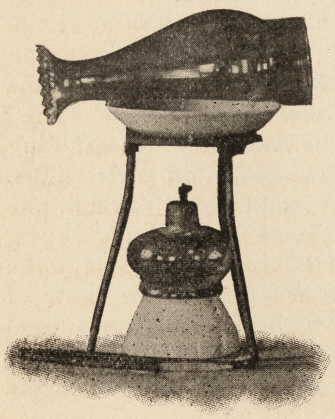

FIG. 9.

which insert an insect pin. The wires are bent and twisted together for a short distance and then made to diverge as shown in Fig. 10. An inflated larvae mounted is shown in Fig. 11.

Labeling Specimens. It is very important in making a collection of insects, to label carefully each specimen, so that it will be possible at any time to tell when and where each one was collected. Moreover, if there is any other data of observation made concerning the insect, it should be recorded in such a way that there can be no doubt of the specimen to which it refers. While it is not practical to give each specimen a dif-

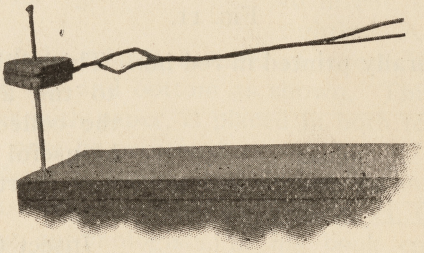

FIG. 10.

ferent number, you can give each species a different number. The label shown in Fig. 12 we find to be useful and practical.

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College Park, Md.	Md.
190	190
Acc. No.	Acc. No.
College Park, Md.	Md.
190	190
Acc. No.	Acc. No.

FIG. 12.

On these are shown the location, the date of collecting the specimen and the accession number. This accession number refers to an accession book or card catalogue in which there are corresponding numbers and in which is written such data as is obtained concerning the specimens. These labels can be printed at a small expense, or they can be written, but it is best to have them as small as possible. Another label containing the generic and specific name of the insect should be attached to each specimen. In arranging specimens in a permanent collection labels should be placed at the head of each group indicating the order, family and genus. The size of the labels generally used

for each respective classification is shown in Fig. 13. The

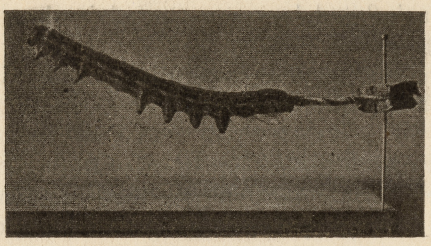

FIG. 11.

labels are generally printed in red ink. This will not only add to the appearance of the collection but will be useful in looking up any particular specimen.

ORDER

FAMILY

GENUS

GENUS
SPECIES

FIG. 13.

Insect Cases. It will not be practical to discuss the many forms of insect cases employed. It is left to the teacher to select the one that is best suited to his needs. But it should be born in mind that an insect case should be tight so as to exclude insects which may prey upon their kind. A small beetle, "the museum pest," if it gains access to a collection, will destroy many mounted specimens in a short time. If this pest should appear, its work being detected by the small amount of dust under each specimen, or by examining the specimens closely and observing that they are being mutilated, the case should at once be fumigated with carbon bisulphide by pouring a small amount of the liquid in a watch glass or other small vessel and placing this in the case, and keep the latter closed for several hours. By continuing this practice the pest will be eradicated. For temporary use, and especially when it is desirable to avoid unnecessary expense, cigar boxes can be procured in which

the insects can be pinned. Although these are convenient to use, if a teacher or pupil desires to make a permanent collection, some kind of insect case should be employed for the reason given above. A case such as is shown in Fig. 14 is very convenient at times; it is about 12 inches long, 9½ inches wide and 3¾ inches thick, made as illustrated in cut, so it will close tightly. A case of this character will hold a large number of insects as they can be pinned in both top and bottom as shown. Thin cork, which is covered over with paper, is placed in both top and bottom in which pins may be projected.

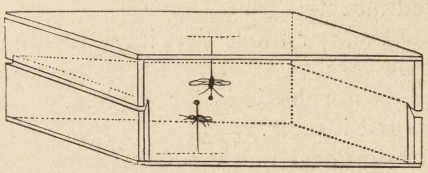

FIG. 13.

The methods of collecting and preserving insects given in this bulletin are recommended by Prof. J. H. Comstock, one of our leading entomologists, in his book entitled "Insect Life," which with Comstock's "Manual of Insects,' the writer commends to every teacher and pupil working with these interesting forms of animal life.

CLASSIFICATION OF INSECTS.

Insects are usually classified into about nineteen orders, but for a simple classification they may be classed into seven orders, viz., Neuroptera, Orthoptera, Hemiptera, Lepidoptera, Diptera, Coleoptera and Hymenoptera.

For the divisions into orders, use is made of wings and mouth structures and of the transformations but for a closer classification other parts of their bodies, such as the different forms of antennae, legs, etc., are taken into consideration.

It is hoped that a key giving a simple classification of our more common forms will soon be ready for publication. Space will only allow giving the orders with the generally excepted commonly known names of the aggregate of insects as follows:

Neuroptera, nerve-winged insects. In its broadest sense this order includes "May-flies," "dragon-flies," "caddice-flies," "white ants," "stone flies," "lace-wing flies," and the like. The mouth parts are Mandibulate and Metamorphosis both complete and incomplete.

Orthroptera, or straight-winged insects.

The roaches, crickets, katydids and grasshoppers illustrate the character of insects classed in this order. The mouth parts are formed for biting, the Metamorphosis is complete.

Hemiptera or half-winged insects.

To this order belong the true bugs or those that have sucking mouthparts such as all "scale insects," "plant lice," "squash bug," "cicades," etc. The Metamorphosis is incomplete.

Lepidoptera. or scaly-winged insects.

This order includes the butterfles and moths. Most amateur collectors are especially attracted to the members of this order, there being a very large variety of attractive specimens. The mouth parts are formed for sucking and the Metamorphosis is complete.

Diptera, or two-winged flies.

A single pair of wings is characteristic of the members of this order. Their Metamorphosis is complete. The mouth parts vary in type but never mandibulate.

Coleoptera, or sheath-winged insects.

This order contains the beetles, a very fascinating class of insects, which are usually very abundant. The mouth parts are mandibulate, and the metamorphosis is complete.

Hymenoptera, or transparent winged insects.

Bees, wasps, ants, and the like are included in this order which stands at the head of the class Insecta. The mouth parts are mandibulate but the tongue is often developed as a lapping organ. The Metamorphosis is complete.

Any specimens sent to the Entomological Department, Maryland Agricultural College, College Park, Maryland, will be gladly determined and any information desired will be given. It is our wish that each school in time may have a permanent collection of insects.

It is to be hoped that the instructors in our public schools will foster this science, which will not only afford pleasure to the pupils, but will train their power of observation and develop a love of nature.